Radial Profiles of Lunar Basins and Large Craters. Charles J. Byrne, Image Again**,** 39 Brandywine Way, Middletown, NJ 07748, charles.byrne@verizon.net, Nicholas G. Lordi, Rutgers University, retired.

Introduction: The estimated center and diameter parameters of basins and large craters has been largely based on photogeologic evidence [1], [2], [3]. Since these parameters were published, additional evidence of the shapes of these impact features has been supplied by Clementine's LIDAR elevation data, now available in the form of Digital Elevation Maps (DEMs) [4], [5]. Examination of the new DEMs confirms many of the previous parameters but some parameters are significantly different, some features are not confirmed as impacts, and new basins can be identified.

Radial elevation profiles: Elevation profiles can be derived from the DEMs. However, linear profiles are very erratic, not only due to instrument noise but also to craters, deposits, and landslides caused by subsequent features, and to the chaotic nature of the impacts themselves. Since most impacts are nearly circular, these effects can be minimized by averaging over azimuth the elevations that are measured at increments of radius from the center of the feature. These profiles reveal the systematic pattern of an impact. This abstract summarizes results from examining such averaged elevation profiles of lunar impact features whose diameter is greater than 200 km. The radial profiles were generated from the topogrd2 DEM [4] rather than ULCN-2005 [5] because the smoothing used in [5] reduced the local depth variations in the radial profiles.

Target topography: The shape of each impact feature is superposed on the shape of the initial target surface. This is obviously true of elevation, but is also true of slope and curvature. Slope is automatically removed by the averaging over 360º of azimuth, but average elevation and curvature are preserved in the profiles and must be estimated and subtracted to reveal the characteristic shape of the impact feature (Fig. 1) [6].

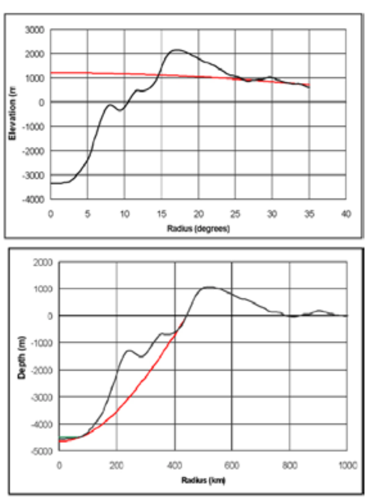

Fig. 1:
Top: Elevation radial profile of the Orientale Basin before subtracting the estimated elevation and curvature of the target surface.
Bottom: Depth radial profile of the Orientale Basin after subtracting the elevation and curvature. Radius has been converted to km.

Part of this process is identification of the precise center of the feature by trial and error, until the characteristic impact shape is revealed. In principle, curvature is two-dimensional (consider a ridge or saddle), but only symmetric curvature is considered in these profiles.

Confirmed feature parameters: In most cases, the parameters of features previously identified as large craters or basins have been confirmed by their radial profiles (Fig. 2 and 3). The diameters measured by the radial profile method are apparent diameters, determined by the intersection of the feature with the estimated target surface [7]. The photogeologic diameters are about 5% larger than those from the radial profiles, suggesting that those diameters are for the inner slope of the rim, rather than the apparent diameter.

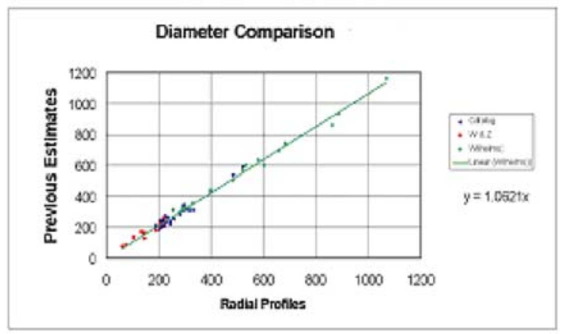

Fig. 2: Comparison of the diameter of various features as previously reported with that derived from radial profiles for the set of features with confirmed parameters.

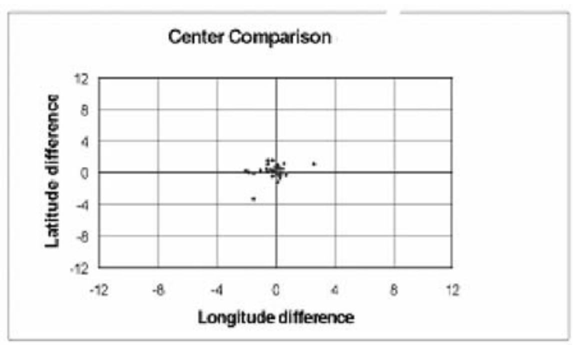

Fig. 3: Comparison of the center coordinates of various features as previously reported with that derived from radial profiles.

Significant variations of parameters: Significant variations were found for a few features. Most of these cases involve multi-ring basins, and the discrepancy can often be attributed to the identification of the main ring. (see Fig. 4 and Table 1). The criteria for significance were taken as a variation of 5% in diameter or 3º in center location.

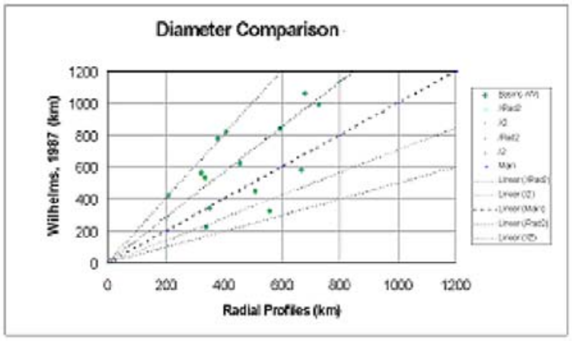

Fig. 4: Comparison of the diameter of various features as previously reported with that derived from radial profiles, where the parameters are significantly different. The outer lines are where the diameters of inner and outer rings would be, if they are in the "radical two" ratio with the main ring.

Table 1: Features with different parameters

Name	Suspected Reason
Campbell Basin	Old diameter was 2nd outer ring
Coulomb-Sarton Basin	Old diameter was 1st outer ring
Crisium Basin	Old diameter was 1st outer ring
Fecunditatis Basin	Old diameter was 1st outer ring
Humorum Basin	Old diameter was 2nd outer ring
Ingenii Basin	Old diameter was 1st outer ring
Keeler-Heaviside Basin	Old diameter was 2nd outer ring
Marginis Basin	Center (latitude)
Moscoviense Basin	Center (latitude and longitude)
Poincaré Basin	Center (longitude)
Schiller-Zuchius Basin	Old diameter was inner ring
Smythii Basin	Old diameter was 1st outer ring
South Pole-Aitken Basin	Center (longitude)

Grimaldi is an example of a feature where the 210 km diameter from the radial profile (Fig, 5 Left) is much smaller than the usually accepted value. (430 km). A review of the digital elevation map (Fig. 5 Right) suggests that there may not be a subdued basin around the crater Grimaldi [10]. The perception of the larger main ring from photogeology may be influenced by crater walls of surrounding impacts and by the ejecta blanket of the Orientale Basin.

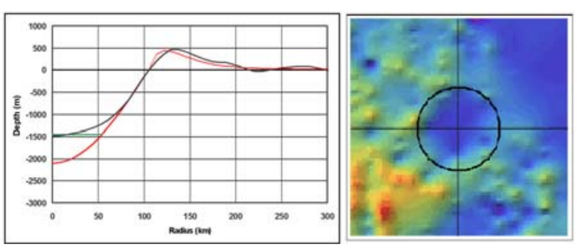

Fig. 5
Left: Radial profile of Grimaldi, a typical impact crater with mare fill. The apparent diameter is 210 km.
Right: Digital Elevation Map based on ULCN-2005 [5]. The solid ring is the 210 km apparent diameter of the radial profile.

Unconfirmed features: For some previously identified basins, primarily some of those identified as "possible" basins, the profiles do not confirm an impact feature. These basins are Al-Kwarismi-King, Balmer-Kapteyn, Flamsteed-Billy, Gargantuan, Insularum, Mutus-Vlacq, Pingre-Hausen, Procellarum, and Werner-Airy. Note that an impact feature could be so modified that its radial profile is not clear.

New features: Several new basins and large craters have been identified, some by inspection of basins that could not be directly confirmed and some by examination of the LIDAR and ULCN-2005 topography. (Table 2).

Table 2: New impact features

Name	Lat.	Long.	Diam. km
Near Side Megabasin [8], [9]	8.5	22.0	6640
St.John - Tselius	10.0	163.0	1600
Australe North	-25.0	98.6	1020
Lavoissier-Mairan [11]	40.0	-59.6	840
Ventris-Van De Graaff	20.2	162.8	760
Cardanus-Herodotus	22.0	-62.0	580
Sinus Asperitatis East	-5.0	26.8	560
Australe South	-37.0	97.2	544
Hermann-Flamsteed	-2.0	-54.6	520
Raimond-Engelhardt	13.3	158.8	388
Cassegrain-Pikel'ner	-49.0	115.8	328
Australe Southeast	-58.2	102.5	226
Sinus Asperitatis West	-7.6	22.4	210

Summary: Radial profiles, based on digital elevation maps, supplement photogeology for characterizing large impact features. Usually, the additional evidence confirms the measurements of photogeology but sometimes it brings those measurements into question. In addition, radial profiles can identify new features. These results should be compared with other estimates made from examination of the Clementine elevation data [10], [11], [12].

References: [1] Andersson, L.E. and Whitaker, E.A. 1985, NASA Catalof of Lunar Nomenclature, NASA Ref. Pub. 1097, 1982. [2] Wilhelms, D.E., et al., A Geologic History of the Moon, USGS Professional Paper 1348, US Gov. Printing Office, 1987. [3] Williams, K.K. and Zuber, M.T., Measurement and Analysis of Lunar Basin Depths from Clementine Altimetry, Icarus 11,(1998). [4] Zuber, M.T., Smith, D. E., and Neumann, G.A., Topogrd2, University of Washington at St. Louis, http//wufs.wustl.edu/geodata/clem1-gravity-topo-v1/, 2004. [5] Archinal, B.A. et al., The Unified Lunar Control Network 2005, USGS, http://pubs.usgs.gov/of/2006/1367/. [6] Byrne, C.J., Radial profiles of lunar basins, LPSC 2006, Abstract 1900, 2006. [7] Turtle, E.P. et al., Impact structures: what does crater diameter mean? Geological Society of America, Special Paper 384: 1-24, 2005. [8] Byrne, C.J., A large basin on the near side of the Moon, Earth, Moon, and Planets, 2008. [9] Byrne, C.J., *The Far Side of the Moon: A Photographic Guide*, Springer, New York, 2008. [10] Spudis, P.D. et al., Science 266, 1884-1851, [11] Zuber, M.T. et al., Science, 266, 1839-1843, 1994. [12] Frey, H.V., Previously Unrecognized Large Lunar Impact Basins Revealed by Topographic Data, LPSC 2008, Abstract 1344.